

complete list of the localities of our ferns. The latter author has made very similar blunders in printing the singular names of these places, and those who are not intimately acquainted with the Snowdonian mountains may well be excused for transcribing them incorrectly.

No notice is taken of *Polypodium alpestre* and its ally or variety *P. flexile*, in the place which it might have been expected to occupy; but probably Mr. Johnson intends to adopt Mr. Newman's genus *Pseudathyrium*. Neither do we find any remark upon the *Lastrea uliginosa* of Newman, which, if not a variety of *L. cristata*, as some suppose, should find a place between that plant and *L. spinulosa*.

The plates bear out the remark in the Prospectus, that "the figures will be all accurately drawn and engraved from the respective plants, and thus many errors in identity and general detail, which had unavoidably occurred in 'English Botany,' will be rectified." Still, there are manifest traces of the 'Eng. Bot.' plates being before the artist when preparing those now issued.

We look forward with much interest to the publication of the successive parts, and shall probably again notice the work when it is further advanced.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

June 15, 1854.—The Earl of Rosse, President, in the Chair.

"Contributions to the Anatomy of the Brachiopoda." By Thomas H. Huxley, F.R.S.

In the course of the dissection of certain Brachiopoda with which I have recently been engaged, I have met with so many peculiarities which are unnoticed in the extant and received accounts of their anatomy, that although the pressure of other duties prevents me from attempting to work out the subject with any degree of completeness for the present, I yet gladly avail myself of the opportunity of communicating a few of the more important results at which I have arrived, in the hope that they may find a place in the Proceedings of the Royal Society.

My investigations were principally made upon *Rhynchonella psittacea*, for specimens of which I am indebted to Prof. Edward Forbes, while Dr. Gray obligingly enabled me to compare them with *Waldheimia flavescens* and with *Lingula*.

1. *The Alimentary Canal of Terebratulidæ*.—Professor Owen, in both his earlier and his later memoirs on the anatomy of the Terebratulidæ, describes at length the manner in which the intestine, as he states, terminates on the right side between the lobes of the mantle.

On the other hand, Mr. Hancock has declared himself unable to observe at this point any such anal aperture, and concludes from his own observations that the latter is situated on the ventral surface of the animal in the middle line, just behind the insertion of the great

adductor muscle. M. Gratiolet, in a late communication to the Académie des Sciences, takes the same view. To get rid of the obvious difficulty, that this spot is covered by the shell, and therefore that if the anus existed here, there would be no road of escape for the fæces, Mr. Hancock and Mr. Woodward appear to be inclined to suppose that some cloacal aperture must exist in the neighbourhood of the pedicle.

The existence of any such aperture, however, has recently been denied with great justice by Professor Owen.

The result of my own repeated examinations of *Rhynchonella psittacea* and of *Waldheimia flavescens* is—1. that the intestine does not

Fig. 1.

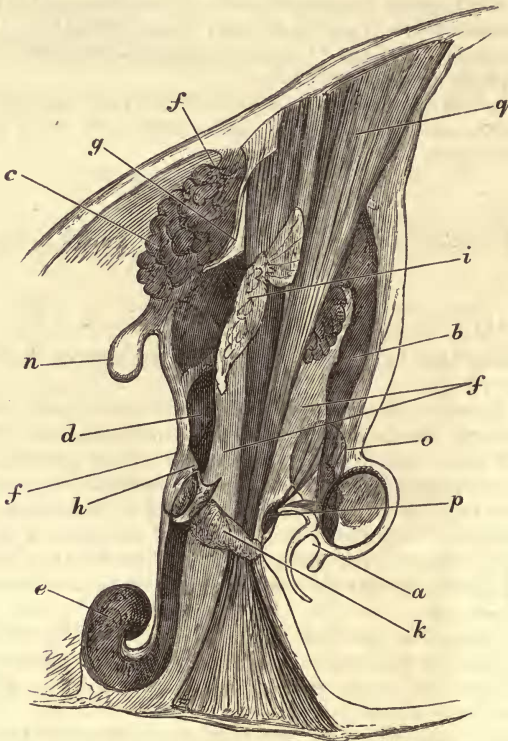


Fig. 1. *Rhynchonella psittacea*, viewed in profile; the lobes of the mantle and the pedicle being omitted.

Fig. 2. The same viewed from behind, the pedicle having been cut away. The left half of the body and the liver are omitted.

a. mouth; b. œsophagus; c. stomach and liver; d. intestine; e. imperforate rectum; f. mesentery; g. gastro-parietal bands; h. ilio-parietal bands; i. superior 'heart'; k. inferior 'heart'; l. genital bands; m. openings of pallial sinuses; n. pyriform vesicle; o. sac at the base of the arm; p. ganglion; q. adductors.

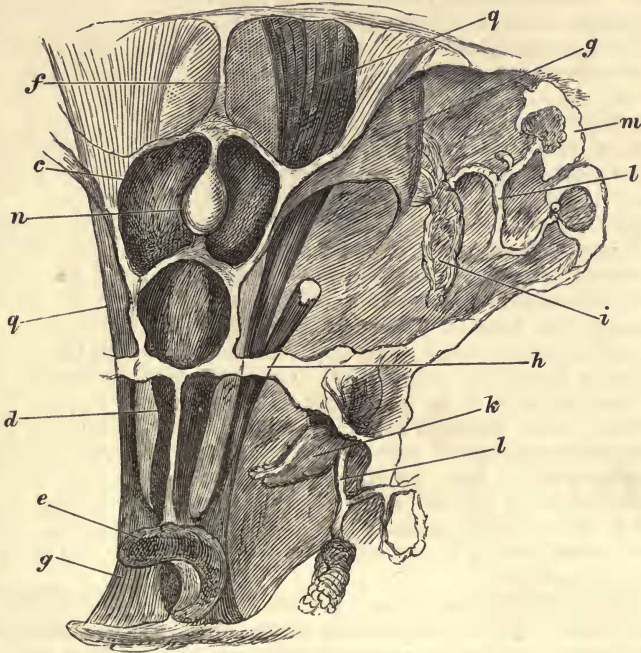
terminate on the right side of the mantle as Professor Owen describes it, but in the middle line, as Mr. Hancock describes it in *Waldheimia*, while in *Rhynchonella* it inclines, after curving upwards, to the left side; and 2. that there is no anus at all, the intestine terminating in a rounded cæcal extremity, which is straight and conical in *Waldheimia*, curved to the left side and enlarged in *Rhynchonella*.

I confess that this result, so exceptional in its character, caused me no small surprise, and I have taken very great pains to satisfy myself of the accuracy of my conclusion; but notwithstanding the strong prejudice to the contrary, to which the known relations of the anal aperture in *Lingula* gave rise, repeated observation has invariably confirmed it.

Professor Owen's statement is, that in *Rhynchonella* (*Terebratula psittacea*) "the intestine inclines to the right side and makes a slight bend forwards before perforating the circumscribing membrane in order to terminate between the mantle lobes on that side."—*On the Anatomy of the Brachiopoda*, p. 152.

I find, on the contrary (figs. 1 and 2), that the intestine passes

Fig. 2.



at first straight downwards in the middle line, as in *Waldheimia*, but instead of terminating in a rounded tapering extremity as in that genus, it bends upwards and then curves round to the left side,

forming a sort of free cæcum in the visceral cavity. My reasons for believing that it is a free cæcum are these:—in the first place, no anal aperture can be detected in the mantle cavity, either on the right or left sides, although the small size of the animal allows of its being readily examined uninjured, with considerable magnifying powers.

Secondly. If the shell be removed without injuring the animal and the visceral cavity be opened from behind by cutting through its walls close to the bulb of the pedicle, it is easy not only to see that the disposition of the extremity of the intestine is such as I have described it to be, but by gentle manipulation with a needle to convince oneself that it is perfectly unattached. And in connexion with this evidence I may remark, that the tissues of the Brachiopods in general are anything but delicate; it would be quite impossible for instance to break away the end of the intestine of *Lingula* from its attachments without considerable violence.

Thirdly. If the extremity of the intestine, either in *Rhynchonella* or in *Waldheimia*, be cut off and transferred to a glass plate, it may readily be examined microscopically with high powers, and it is then easily observable that its fibrous investment is a completely shut sac. In *Rhynchonella* the enlarged cæcum is often full of diatomaceous shells, but it is impossible to force them out at its end, while if any aperture existed they would of course be readily so extruded.

However anomalous, physiologically, then, this cæcal termination of the intestine in a molluscous genus may be, I see no way of escaping from the conclusion that in the *Terebratulidæ* (at any rate in these two species) it really obtains. There are other peculiarities about the arrangement of the alimentary canal, however, of which I can find either no account at all or a very imperfect notice.

The intestinal canal (figs. 1 and 2 *b, d, e*) has an inner, epithelial, and an outer fibrous coat; the latter expands in the middle line into a sort of mesentery, which extends from the anterior face of the intestine between the adductors, to the anterior wall of the visceral chamber, and from the upper face of the intestine to the roof of the visceral chamber; while posteriorly it extends beyond the intestine as a more or less extensive free edge. I will call this the *mesentery* (*f*).

From each side of the intestinal canal, again, the fibrous coat gives off two 'bands,' an upper (*g*), which stretches from the parietes of the stomach to the upper part of the walls of the visceral chamber, forming a sort of little sheath for the base of the posterior division of the adductor muscle, which I will call the *gastro-parietal band*; and a lower, which passes from the middle of the intestine to the parietes, supporting the so-called '*auricle*.' I will call this the *ilio-parietal band* (*h*).

The ilio-parietal and gastro-parietal bands are united by certain other ridges upon the fibrous coat of the intestine, from whose point of union in the middle line of the stomach posteriorly, a pyriform vesicle (*n*) depends.

The mesentery divides the liver into two lateral lobes, while the gastro-parietal bands give rise to the appearance that these are again

divided into two lobules, one above the other. I am inclined to think that these bands are what have been described as 'hepatic arteries,' at least there is nothing else that could possibly be confounded with an arterial ramification upon the liver.

This description applies more especially to *Rhynchonella* and *Waldheimia*, but the arrangement in *Lingula* is not essentially different.

2. *The Circulatory System of Terebratulidæ*.—Considerable differences of opinion have prevailed among comparative anatomists as to the nature and arrangement of the vascular system in the Brachiopoda. A pair of organs, one on each side of the body, have been recognized as Hearts since the time of Cuvier, who declared these hearts in *Lingula* to be aortic, receiving the blood from the mantle and pouring it into the body, the principal arterial trunks being distributed into that glandular mass which Cuvier called ovary, but which is now known to be the genital gland of either sex.

Professor Owen in his first memoir follows Cuvier's interpretation, stating that in *Orbicula* the pallial veins terminate in the hearts, from which arterial branches proceed to the liver and ovary. Professor Owen further adds for the Brachiopoda in general,—

"Each heart, for example, in the Brachiopoda is as simple as in *Ascidia*, consisting of a single elongated cavity, and not composed of a distinct auricle and ventricle as in the ordinary Bivalves," and he compares the hearts of Brachiopoda to the auricles of *Arca*, &c. (Trans. Zoological Society, vol. i. p. 159.)

In 1843, however, M. Vogt's elaborate memoir on *Lingula* appeared, in which the true complex structure of the 'heart' in this genus was first explained and the plaited 'auricle' discriminated from the 'ventricle'; and in 1845, Professor Owen, having apparently been thus led to re-examine the circulatory organs of Brachiopoda, published his 'Lettre sur l'appareil de la Circulation chez les Mollusques de la Classe des Brachiopodes,' in which he felicitates M. Milne-Edwards on the important confirmation of the views which the latter entertains with respect to the lacunar nature of the circulation in the Mollusca, afforded by the Brachiopoda, and describes each heart of the Terebratulidæ as consisting of a ventricle and a plaited auricle, the pallial veins not terminating in the latter, but in the general visceral cavity. As the Professor does not recall the view which he had already taken of the circulation in *Orbicula*, I presume that he considers two opposite types of the circulatory organs to obtain in the Brachiopoda, the direction of the current being from the mantle through the heart towards the body in *Orbicula*, and from the mantle through the body towards the heart in *Terebratula*.

The possibilities of nature are so various that I would not venture, without having carefully dissected *Orbicula*,—no opportunity of doing which has yet presented itself,—to call this view in question, but I think it seems somewhat improbable. Indeed the structural relations which I have observed, and which are described below, do not appear to me to square with any of the received doctrines of Bra-

chiopod circulation, but I offer them simply as facts, not being prepared at present to present any safe theory on the subject.

In *Waldheimia flavescens* there are two 'hearts,' situated as Professor Owen describes them, but so far as I have been able to observe, the ventricle cannot be described as an 'oval' cavity, inasmuch as it is an elongated cavity bent sharply upon itself. Hastily examined of course this may appear oval. I have been similarly unable to discover 'the delicate membrane of the venous sinuses,' which is said by Professor Owen to "communicate with and close the basal apertures of the auricles," or to perceive that the auricular cavity can be "correctly described as a closed one, consisting at the half next the ventricle, of a beautifully plicated muscular coat in addition to the membranous one, but at the other half next the venous sinus of venous membrane only; the latter might be termed the auricular sinus, the former the auricle proper."

I presume that 'this delicate membrane of the venous sinuses' is what I have called the ilio-parietal band, in which the base of the auricle is as it were set, like a landing-net in its hoop, but this does *not* close the base of the auricle, the latter opening widely into the visceral chamber.

I have equally failed in detecting any arteries continued from the apices of the ventricles; and I have the less hesitation in supposing I have not overlooked them, as Mr. Albany Hancock, whose works are sufficient evidence of the value of his testimony, permits me to say that he long since arrived at the conclusion that no such arteries exist.

What has given rise to the notion of the existence of these arteries appears to me to be this. A narrow band resembling those I have already described, is attached in *Waldheimia* along the base of the 'ventricle' and the contiguous outer parietes of the auricle: inferiorly it passes outwards to the sinuses, and running along their inner wall, forms a sort of ridge or axis* from which the genitalia, whether ovaria or testes, are developed, stretching through their whole length and following the ramifications of the sinuses. It is the base of these ridges seen through the walls of the sinuses, where they extend beyond the genitalia, which have been described as arteries.

The upper end of the band passes into the sinuses of the upper lobe of the mantle, and comes into the same relation with the genitalia which they enclose.

The walls of the auricle in *Waldheimia* are curiously plaited, but I have been unable, in either auricle or ventricle, to detect any such arrangement of muscular fibres as that which has been described. The epithelial investment of the auricle, on the other hand, is well developed, and in the ventricle the corresponding inner coat is raised up into rounded villous eminences.

The ventricle lies in the thickness of the parietes, while the auricle floats in the visceral cavity, supported only by the ilio-parietal band. The former is at first directed downwards, but then bends sharply

* This arrangement is, I find, particularly described by M. Gratiolet.

round and passes upwards to terminate by a truncated extremity close to the subœsophageal ganglion and bases of the arms.

Mr. Hancock informs me, that in his dissections he repeatedly found an aperture by which the apex of the 'ventricle' communicated with the pallial cavity; and that, taking this fact in combination with the absence of any arteries leading from this part, he had been tempted to doubt the cardiac nature of these organs altogether, and to regard them rather as connected with the efferent genital system, had not the difficulty of determining whether these apertures were artificial or natural prevented his coming to any definite conclusion at all.

Before becoming acquainted with Mr. Hancock's investigations, I had repeatedly observed these apertures in *Rhynchonella*, but preoccupied with the received views on the subject, I at once interpreted them as artificial. A knowledge of Mr. Hancock's views, however, led me to reconsider the question, and I have now so repeatedly observed these apertures both in *Waldheimia* and in *Rhynchonella*, that I am strongly inclined to think they may after all be natural.

If these organs be hearts, in fact, *Rhynchonella* is the most remarkable of living Mollusks, for it possesses *four* of them. Two of these occupy the same position as in *Waldheimia*, close to the origins of the calcareous crus (*k*), while the other two are placed above these, and above the mouth, one on each side of the liver (*i*). It is these latter which Professor Owen describes, while he has apparently overlooked the other two; at least he says (speaking as I presume of *Rhynchonella*) (*l. c.* p. 148) that the venous sinuses "enter the two hearts or dilated sinuses which are situated exterior to the liver, and in *T. Chilensis* and *T. Sowerbii* just within the origins of the internal calcareous loop."

The fact is, that while the ilio-parietal bands support two 'hearts' as usual, the gastro-parietal bands are in relation with two others. The base of the 'auricle' of the latter opens into the re-entering angle formed by the gastro-parietal band with the parietes, while its apex is directed backwards to join the ventricle, which passes downwards and backwards along the posterior edge of the posterior division of the adductor muscle.

The auricles in *Rhynchonella* are far smaller, both actually and proportionally, than in *Waldheimia*. They exhibit only a few longitudinal folds, and not only present the same deficiency of muscular fibres as those of *Waldheimia*, but are so tied by the bands which support them that it is difficult to conceive how muscular fibres, even if they existed, could act. The 'ventricles' in like manner lie obliquely in the parietes of the body, and simply present villous eminences on their inner surface, which has a yellowish colour.

All these 'hearts' exhibit the same curious relation with the genitalia in *Rhynchonella* as in *Waldheimia*; that is to say, a 'genital band' (*l*) proceeds from the base of the 'ventricle' and becomes the axis of the curiously reticulated genital organ. But in *Rhynchonella* the genital bands of the upper genitalia come from their own 'hearts.'

The arrangement of the genitalia in *Rhynchonella* is very remarkable. The sinuses have the same arrangement in each lobe of the mantle. The single trunk formed by the union of the principal branches in each lobe opens into the inner and anterior angle of a large semilunar sinus which surrounds the bases of the adductors, and opens into the visceral cavity. The floor of this great sinus is marked out into meshes by the reticulated genital band, and from the centre of each mesh a flat partition passes, uniting the two walls of the sinus, and breaking it up into irregular partial channels.

There are the same anastomosing bands uniting the gastro-parietal and ilio-parietal bands on the stomach in *Rhynchonella* as in *Waldheimia*, and a pyriform vesicle of the same nature, but I did not observe in *Rhynchonella* those accessory vesicles upon the origins of genital bands, which I observed once or twice in *Waldheimia*.

I could find no trace of arteries terminating the elongated, ovoid and nearly straight 'ventricles' of *Rhynchonella*; their ends appeared truncated, and as I have already said, repeatedly presented a distinct external aperture.

Such appear to me to be the facts respecting the structure of the so-called hearts in the *Terebratulidæ*; what I believe to be an important part of their peripheral circulatory system, has not hitherto, so far as I am aware, received any notice.

In *Waldheimia* the membranous walls of the body, the parieto-intestinal bands and the mantle, present a very peculiar structure; they consist of an outer and an inner epithelial layer, of two corresponding fibrous layers, and between them of a reticulated tissue, which makes up the principal thickness of the layer, and in which the nerves and great sinuses are imbedded.

The trabeculæ of this reticulated tissue contain granules and cell-like bodies, and I imagined them at first to represent a fibro-cellular network, the interspaces of which I conceived were very probably sinuses. Sheaths of this tissue were particularly conspicuous along the nerves. On examining the arms, however, I found that the oblique markings, which have given rise to the supposition that they are surrounded by muscular bands, proceeded from trabeculæ of a similar structure, which took a curved course from a canal which lies at the base of the cirri (not the great canal of the arms, of course) round the outer convexity of the arm, and terminated by breaking up into a network. These trabeculæ, however, were not solid, but hollow, and the interspaces between them were solid. The network into which they broke up was formed by distinct canals, and then, after uniting with two or three straight narrow canals which ran along the outer convexity of the arm close to its junction with the interbrachial fold, appeared to become connected with a similar system of reticulated canals which occupied the thickness of that fold.

It was the examination of the interbrachial fold, in fact, which first convinced me that these reticulated trabeculæ were canals; for it is perfectly clear that vessels or channels of some kind must supply the proportionally enormous mass of the united arms with their

nutritive material, and it is so easy to make thin sections of this part, that I can say quite definitely that no other system of canals than these exists in this locality.

The *facts*, then, with regard to the real or supposed circulatory organs of the *Terebratulidæ*, are simply these:—

1. There are two or four organs (hearts), composed each of a free funnel-shaped portion with plaited walls, opening widely into the visceral cavity at one end, and at the other connected by a constricted neck, with narrower, oval or bent, flattened cavities, engaged in the substance of the parietes. The existence of muscular fibres in either of these is very doubtful. It is certain that no arteries are derived from the apex of the so-called ventricle, but whether this naturally opens externally or not is a point yet to be decided.

2. There is a system of ramified peripheral vessels.

3. There are one or more pyriform vesicles.

4. There are the large 'sinuses' of the mantle, and the 'visceral cavity' into which they open.

To determine in what way these parts are connected and what functions should be ascribed to each, it appears to me that much further research is required.

Nervous System of Terebratulidæ.—Professor Owen describes and figures the central part of this system as a ring surrounding the oral aperture, its inferior portion being constituted by a mere commissural band.

M. Gratiolet, however, states with justice that the inferior side of this collar is the thicker, and I find both in *Rhynchonella* and in *Waldheimia* that it constitutes, in fact, a distinct oblong ganglion, of a brownish colour by reflected light. From its extremities commissural branches pass round the mouth, while other cords are distributed to the arms, to the superior and inferior pallial lobes, and to the so-called hearts. The nerves are marked by fine and distinct longitudinal striations, and can be traced to the margins of the pallial lobes, where they become lost among the muscular fibres of the free edges of the mantle.

Structure of the Arms.—I have not been able to convince myself of the existence of that spiral arrangement of the muscular fibres of the arms which has been described in *Rhynchonella* and *Waldheimia*. I have found the wall of the hollow cylinder of the arm to be constituted (1) externally by an epithelium, within which lie (2) the reticulated canals, which have been already described; (3) by a delicate layer of longitudinal or more oblique and transverse fibres, which are probably muscular, and (4) internally by a granular epithelial layer.

In *Rhynchonella* the bases of the arms are terminated by two considerable sacs, which project upwards into the visceral cavity. Have these the function of distending and so straightening the spirally coiled, very flexible arms of this species?

Affinities of the Brachiopoda.—All that I have seen of the structure of these animals leads me to appreciate more and more highly the value of Mr. Hancock's suggestion, that the affinities of the

Brachiopoda are with the Polyzoa. As in the Polyzoa, the flexure of the intestine is neural, and they take a very natural position among the neural mollusks between the Polyzoa on the one hand, and the Lamellibranchs and Pteropoda on the other.

The arms of the Brachiopoda may be compared with those of the Lophophore Polyzoa, and if it turns out that the so-called hearts are not such organs, one difference will be removed.

In conclusion, I may repeat what I have elsewhere adverted to, that though the difference between the cell of a Polyzoon and the shell of a Terebratula appears wide enough, yet the resemblance between the latter with its muscles and the Avicularium of a Polyzoon, is exceedingly close and striking.

ZOOLOGICAL SOCIETY.

November 25, 1851.—W. J. Broderip, Esq., F.R.S., Vice-President, in the Chair.

ON A SPECIES OF *ÆQUOREA* INHABITING THE BRITISH SEAS. BY PROF. EDWARD FORBES, F.R.S.

In the first volume of the 'Wernerian Memoirs' a "*Medusa æquorea*" is mentioned by Prof. Jameson as an inhabitant of the seas of the north of Scotland, and in the 'History of British Animals' by Dr. Fleming, the name "*Geryonia æquorea*" is used to designate it. As no description or figure was ever published of this creature, and as the diagnosis of the "*Medusa*" to which Linnæus applied the name of "*æquorea*" was too brief for identification, it is possible that some one out of several Acalephæ inhabiting our seas might have been intended.

It is also possible, however, that a true *Æquorea* had been seen, for there is a most beautiful species of this genus an inhabitant of the Scottish seas. I met with it for the first time in August 1850, when exploring the Minch (the channel between the outer Hebrides and Skye) in company with Mr. MacAndrew and Prof. Goodsir, with the advantages of the appliances for natural-history research with which Mr. MacAndrew has furnished his yacht, the *Naiad*. As there is neither figure nor description of any British *Æquorea* to be found, and as considerable obscurity hangs around the Atlantic species of the genus, I have drawn up the following notice.

A number of individuals were observed: they were swimming near the surface of the sea on a very calm and hot day: they varied in size, from three inches in diameter to as much as half a foot or more: they resembled broad shield-shaped discs of glass, slightly prominent above, incurved at their sides and concave beneath: through the discs were seen shining the pendent brown-tinged stomach, and around it, like so many equal stripes or rays proceeding to the margin, the linear violet genital glands: from the margin depended highly-tractile violet tentacles.

The umbrella is broad, shallow, and disc-shaped, its outline de-